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14. ABSTRACT

Funds were requested for a survey system to measure bathymetry and morphological evolution on macrotidal flats. The survey system was used in conjunction with an array of current meters, pressure gages, CTDs, and anemometers to provide field observations to calibrate, evaluate, and improve both research and operational models for circulation, sediment transport, and morphological change on tidal flats. In addition, the survey measurements provided ground truth for remote sensing studies, and background information for other investigations of fluid and sediment processes. There are few measurements of the morphological evolution of the muddy bottoms found on most macrotidal flats, at least partly owing to the difficulty of collecting data in this shallow-water environment. However, recently developed techniques, including LIDAR and GPS-based sensors allow the bathymetry to be mapped from near the high-tide line to the deep edge of tidal flats. Bathymetric surveys are necessary to develop and test numerical model simulations of the behavior of large-scale macrotidal flats in response to currents and riverine flows. The survey system requested here will expand existing capabilities substantially by enabling investigations of the processes leading to evolution of macrotidal mud flats. Undergraduate fellows, graduate students, and post-doctoral researchers will utilize the survey system in student projects, thesis research, publications, and presentations at national and international meetings.

15. SUBJECT TERMS

tidal flats, surfzone, nearshore circulation, sediment transport

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Final Technical Report for DURIP N00014-09-1-0933
Survey System to Measure Bathymetry and Morphological Evolution on Macrotidal Mud Flats

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This DURIP was to purchase equipment to build survey systems for shallow water and the shoreline.

1) A wave runner-based, GPS+sonar survey system (Figure 1) was constructed and tested (successfully).

Figure 1: Photograph of the wave runner based GPS (white disk on stern is the antenna) and sonar (under the hull) survey system. The yellow box on the handlebars contains a water proof computer to operate the system and to display a map of transect lines for the operator to follow while mapping the seafloor.

2) A surfboard-based GPS+sonar survey system (Figure 2) for inner surf zone mapping. An example map of the inner surf zone seafloor where a large hole had been excavated is shown in Figure 3.

Figure 2: Photograph of the surfboard based GPS (white disk in center is the antenna) and sonar (under the surfboard) survey system. The white box on the handlebars contains a waterproof computer to operate the system. After carrying the 70 pound device to the water line, a swimmer paddles the surfboard along cross-and alongshore transects to map the sea floor in very shallow water.

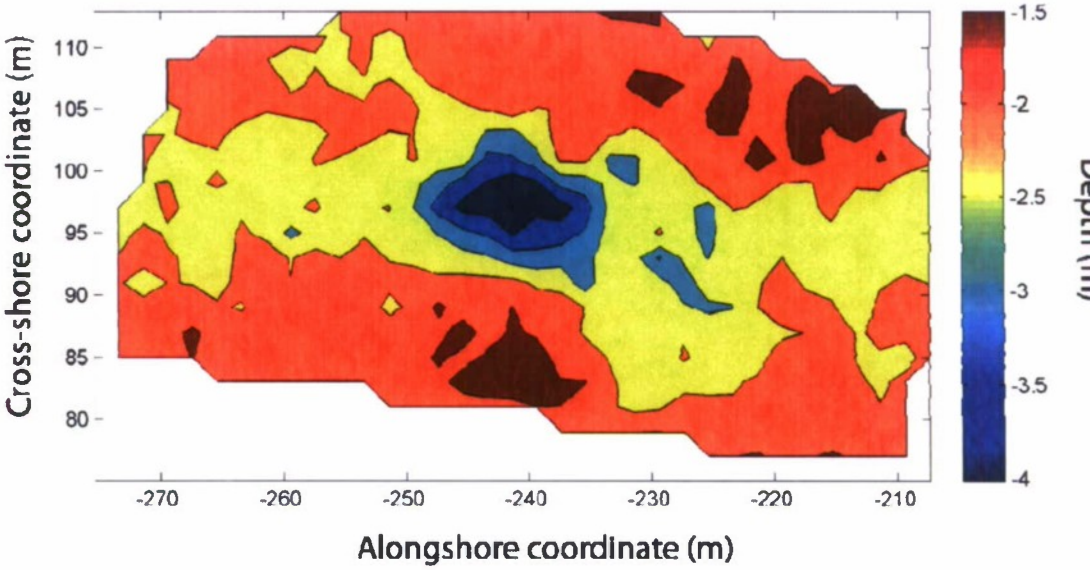

Figure 3: Contours of water depth (color scale on the right side) in the inner surfzone as a function of cross- and alongshore coordinate. The 4 m deep hole is shown in blue, and the trough between the shoreline (cross-shore coordinate approximately 60 m) and the inner sand bar (cross-shore coordinate approximately 120 m) is in yellow. The inner surfzone is an extremely difficult place to survey owing to big waves, strong currents, suspended sediments, and bubbles.

Equipment Purchased For this Project (Grant No. N00014-09-1-0933):

(1) 2008 F-250 Ford Super Duty 4x4 Pickup Truck

(1) 2009 Yamaha ATV

(1) Riegl USA 3-D Imaging Sensor

(1) 2009 GTX 215 Bombadier Watercraft

(2) Sea Nav Electronics KVH Gyro Trac

(2) Survey Sonar Systems

(2) Keystone Precision Instruments R720146 Trimble R7 GNSS Rover

(1) Ribcraft 6.5 Professional Outboard Configuration

(2) Armor X10 Rugged Tablet Computer

(1) Keystone Precision Instruments GPS Base Station

(2) Nortek USA 2 MHz Aquadopp Profilers

(1) MAC Book Air

The *Riegel lidar* is used for surveys of tidal flats, beaches, and other nearshore areas, as well as to monitor waves. It was used:

-in Willipa Bay to map the mud flat (in collaboration with J. Thomson, UW),

- in southern California to monitor cliff erosion (R. Guza, A. Clark, UCSD),

- in Duck, NC to measure waves as ground truth for remote sensing studies (J. Thomson, A. Jessup, UW),

- in Duck, NC to measure beach topography and swash in a study of pathogen distribution in beach sands (R. Gast, WHOI).

The *pickup truck* is to mount and transport the lidar to areas of interest and to provide elevation above the surrounding terrain.

In addition to lidar surveys, we constructed several GPS-based systems for performing bathymetric surveys in shallow, nearshore waters:

- A GPS antenna on the *ATV* allows us to survey beaches rapidly.
- GPS and a bottom-finding sonar system mounted on the *waverunner* ("watercraft") and the *boat* ("Ribcraft") are for surveying in shallow water where waves impede access to other vehicles.

The *Aquadopp profilers* are used in a downward-looking configuration to detect the seafloor. They were used in a recent study to monitor the evolution of perturbations to the seafloor as the bottom accreted. In addition, we constructed a shallow water survey system based on a surfboard with GPS and sonars to find the bottom. This system is for use in the surfzone. In some situations, bottom-finding with the *Aquadopps* is more robust than bottom finding with the sonar transducers.

The other items are used within the survey systems. *KVH Gyro Trac* as to correct for tilt-roll-pitch of the survey platforms. The *survey sonar systems* are to find the seafloor. The *Trimble rovers* are the GPS hardware mounted on the vehicles (moved from one to another). The Keystone GPS *base station* is used in combination with the GPS rovers to provide differential GPS for accurate survey locations. The *rugged tablet computers* are the "brains" of the survey systems, allowing us to combine the data streams from GPS, sonar, and KVH systems into one data set. The *MAC Book Air* is used for data acquisition and processing.